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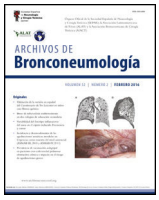

Editorial

Hybrid Procedures for Pulmonary Nodule Resection: The Beginning of a New Era☆

Procedimientos híbridos para la resección de nódulos pulmonares: el comienzo de una nueva era

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Although hybrid procedures have been used for some time in surgical specialties such as vascular surgery or neurosurgery, they have been introduced only relatively recently in thoracic surgery, primarily for the simultaneous localization and resection of pulmonary nodules in a single diagnostic-therapeutic procedure. The use of these techniques has increased steadily over the past few years. This is due in part to the increasingly frequent detection of small pulmonary nodules with part-solid or pure ground glass features, which can be a challenge to locate during surgery, especially in minimally invasive procedures using either Video Assisted Thoracic Surgery (VATS) or robotic procedures.

A series of image-guided techniques are now available to help locate pulmonary nodules as part of the hybrid process.

Transthoracic Insertion of Metal Needles (Hook Wires, Microcoils)

Since the 1990s,[1] pulmonary nodules have been located with the transthoracic insertion of a hook wire, generally in the radiology room a few hours before surgery. A hybrid approach offers a series of advantages over the conventional sequential 2-step procedure: it avoids patient discomfort and stress during transfer between the radiology room and the operating room, reduces the chance of displacement of the hook wire, obviates the need for chest tubes in the case of pneumothorax, and reduces the anesthetic risk, as the procedure is performed with a single induction. In 2015, Gill et al.[2] published a phase I-II clinical trial in which they analyzed the safety and perioperative outcomes of this new hybrid workflow. They studied a series of 23 adults with solid or part-solid pulmonary nodules and ground glass opacities measuring less than 30 mm, who were candidates for atypical segmentectomy using VATS. T-bar fiducials were successfully placed in 87% of the patients, allowing the pulmonary nodule to be localized. Dislodgement occurred in only 3 cases. Nevertheless, all patients underwent complete resection with no surgical conversion. Only 2 patients (8.6%) developed iatrogenic pneumothorax during the implantation of the fiducial. Three patients (13%) had postoperative complications, and all patients survived. These results led the authors to conclude that this transthoracic hybrid approach is feasible, safe, and effective.

Another alternative is the percutaneous insertion of microcoils. These are radiopaque titanium coils that are inserted into the lung parenchyma, near the nodule, leaving one of the ends in the visceral pleura. These characteristics allow the visualization, palpation, and even the localization of the microcoil by fluoroscopy, and confirm the correct position of the endostapler. The success rate for marking and resection is very high, approaching 100%.[3] Finley et al.[4] concluded in a prospective randomized study that this technique reduces the need for thoracotomies or anatomical lung resection in the surgical treatment of small and peripheral pulmonary nodules.

Electromagnetic Navigational Bronchoscopy-Guided Dye Marking

This technique can be used to mark peripheral pulmonary nodules by injecting dye, usually methylene blue, once the locatable electromagnetic guide reaches its target during the navigational procedure. One of the advantages of the hybrid operating room is that we can use the Cone-Beam Computed Tomography (CBCT) scan to check the correct position of the catheter, correct any electromagnetic navigational error, especially in subcentimeter nodules, and, thus, increase the accuracy of the marking.[5]

Most studies of this technique are purely descriptive, and they all report optimal outcomes.[6–12] The percentage of success in marking nodules ranges from 79% to 100%, with a mean electromagnetic navigational time of 18 minutes[6] or 28 minutes,[9] depending on the series. The main cause of failure to mark the lesion is extravasation of the dye into the pleural cavity, preventing correct localization. Only 1 study has analyzed the variables that might influence the

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efficacy of the technique.[8] The authors conclude that the larger the lesion and the nearer it is to the visceral pleura, the greater the chance of success, although their results were not statistically significant. The percentage of postoperative complications is low (0%-6.8%), and no postoperative deaths within 30 days have been reported.[6–10]

Transthoracic Dye Marking

This hybrid procedure was described by Yan et al.[13] in 2016. After interoperative CT, syngo needle guidance software (Siemens Healthcare GmbH, Forchheim, Germany) with skin laser projection can be used to calculate the direction of the needle and its point of entry into the skin. When the needle is introduced and its correct position has been confirmed by a second CT, 0.2 ml of dye is then instilled into the lesion. When the camera is introduced, the pleural surface with the blue-dyed nodule is visualized, and the lung resection is then performed. According to data from Yan et al., the pulmonary lesions could be correctly localized in 23 of 25 patients (92%). The mean time for localization was 46 minutes, and the mean surgical time was 109 minutes. Two patients (8%) had complications during the localization phase (transdiaphragmatic hepatic puncture, complete pneumothorax). Although outcomes are good, more prospective, randomized studies are needed to analyze the efficacy and safety of the technique.

Combined Hybrid Procedures

Two publications in the literature[14,15] describe the hybrid approach using a combination of several of the techniques mentioned above, but the current evidence is insufficient to assess these combined procedures.

In summary, resection of pulmonary nodules using hybrid techniques is increasingly common, due to improved detection of subcentimeter, subsolid or ground glass lesions. However, there are still very few hospitals which perform these multidisciplinary procedures, due to limited resources and the lack of hybrid operating rooms. To further the development of these procedures, more studies are needed to establish the efficacy and perioperative outcomes of these techniques, along with a precise analysis of the economic aspects to examine their use and cost-effectiveness. The best approach may be to start a hybrid thoracic surgery program, using already familiar procedures, such as the transthoracic implantation of metal needles. Other more complex techniques, such as the use of the electromagnetic navigation in the marking of pulmonary nodules, could then follow.

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